600-2703
PCI EXPRESS
EXPANSION SYSTEM
USER’S MANUAL

Revision 1.1, April 2007

Cyclone P/N 800-2703

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CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

The Cyclone Microsystems' 2703 PCI Express Expansion System is a PCI Express (PCIe) expansion system that allows the user to add up to thirteen PCI Express and two PCI-X add-in cards. Most PCs contain few PCI Express slots making them poorly suited for embedded systems requiring a wealth of different I/O boards and co-processor resources.

The 2703 PCI Express Expansion Systems permits system developers to use powerful and cost-effective PCs as a foundation for a robust embedded system. The thirteen PCI Express slots are organized as five x8 slots and eight x4 slots. All expansion slots accommodate full length and full eight cards and are cooled by four 50 CFM fans. A 550 watt supply powers the rack mounted expansion chassis.

The Expansion System supports 20 Gb/s bi-directional traffic to and from the host system and utilizes non-blocking PCI Express switches for excellent peer-to-peer I/O bandwidth. For PCs with modern BIOSs, the 2703 Expansion System is recognized by the host system upon boot-up, requires no hardware specific drivers, and is entirely host operating system agnostic.

The 600-2703 system is composed from three elements: a PCI Express Host Bus Cable Adapter, an Expansion System Cable and an Expansion Chassis. Our PCIe-408 Host Cable Bus Cable Adapter card is inserted into a host computer's PCIe slot. PCIe expansion cable links the PCI host with the expansion chassis. The expansion chassis is populated with two boards, a PCIe-403 SHB Expansion Cable Adapter which is inserted in to the PCIe-412 Switched Backplane.

In an alternate configuration, (600-2602), the PCIe-412 and rack-mount chassis can be populated with a PICMG 1.3 System Host Board and function as a stand-alone embedded system.

PCI Express is a high performance, general purpose I/O inter-connect defined for a wide variety of computing and communication platforms. Key PCI attributes, such as its usage model, load-store architecture, and software interfaces are maintained, whereas its parallel bus implementation is replaced by a serial interface. PCI Express take advantage of recent advances in point-to-point inter-connects, Switch-based technology, and packetized protocol to deliver new levels of performance.

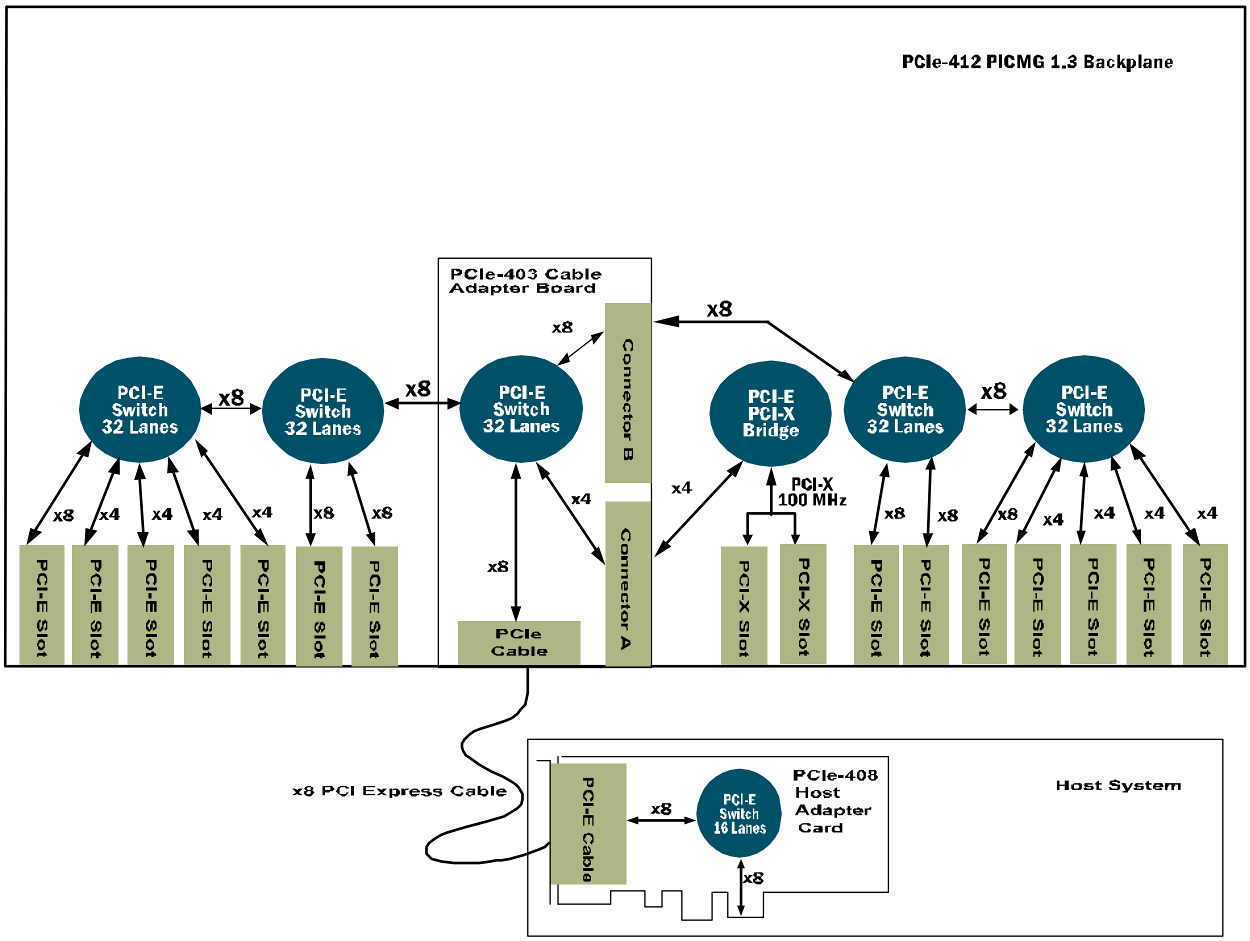


Figure 1-1. 600-2703 Block Diagram

1.2 SPECIFICATIONS

The specifications in table 1-1detail the 600-2703 expansion system chassis including the PCIe-412 expansion backplane, the PCIe-403 PICMG 1.3 slot cable adapter and the 500W power supply. The chassis also includes four 50 CFM fans.

Table 1-1. Specifications

Physical	Height	6.969 inches
	Width	17 inches
	Depth	26.256 inches
	Other	19 inch rack mountable
Electrical	Voltage	90 ~ 263 VAC full range
	Frequency	47 ~ 63 Hz.
	Input Current	8.0 A for 115 CVAC, 4.0 A for 230 VAC.
	Inrush Current	65 A max. for 115 VAC, 125 A max. for 230 VAC.
	Fuse	8.0 A at 250 VAC
Environmental	Operating Temperature	0 to 40 Degrees Celsius
	Relative Humidity	0% to 95% (non-condensing)
	Storage Temperature	-20 to 70 Degrees Celsius

1.3 STANDARDS

PCI Express Base Specification Revision 1.1

PCI Express Card Electro Mechanical Specification 1.1

PCI Express External Cabling Specification 1.0

PICMG SHB Express Revision 1.0

CHAPTER 2
THEORY OF OPERATION

2.1 THEORY OF OPERATION

The basic PCI Express Link consists of dual unidirectional differential links, implemented as a transmit pair and a receive pair. The signaling rate for PCI Express is 2.5 Gigabits/second/Lane/direction. A link supports at least one Lane.

The PCI Express link from the PCIe-408 over the cable to the PCIe-403 is an eight lane (x8) link. The PCIe-412 provides six x8 slots and eight four lane (x4) slots. Note that in the installed chassis, 600-2703, there are only 5 available x8 slots due to one slot being obstructed by the power entry module for the chassis. Each slot can accommodate either single lane (x1), x4 or x8 add-in cards. In the case where a x8 add-in card is installed into a x4 slot, only the first four lanes on the add-in card will be utilized. This situation is termed “down-shifting”. Per the PCI Express Specification, down-shifting is only allowed in this case. All slot connectors on the PCIe-412 are mechanically x8 with the x4 slots leaving the upper four lanes not connected. Up-plugging, i.e., plugging a smaller link card into a larger link connector, is fully allowed.

Once the PCIe-408 is installed into the host PC, the cable connected to the PCIe403, the chassis is plugged into an AC power outlet and any desired add-in cards are installed, the system is ready to be turned on. A number of things happen at this point. First, the PCI Express links are initialized. This is a purely hardware initialization where each PCI Express link is set up following a negotiation of lane widths by the two ends of each link. No firmware or operating system software is involved. Once the links are initialized or “trained”, there are LED indicators on each of three Cyclone Microsystems’ cards that indicate both the links that are trained and the individual lanes. A detailed explanation of the LEDs follows later in this manual.

One essential requirement for system initialization is the ability of the Host system’s BIOS to be able to enumerate the many bridges inherent in a complex PCI Express design. The links from the PCIe-408 through the PCIe-403 to the PCIe-412 are created with PCI Express Switches. Each link looks like a PCI-to-PCI bridge to the Host’s BIOS. The number of bridges can add up quickly. Older BIOS may not have the ability to handle the number of bridges. Make sure that the BIOS on the host computer has the latest updated BIOS. If required, contact the host system’s manufacturer to make sure that the BIOS used can handle the large number of bridges that it will see in the system.

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CHAPTER 3
EXPANSION SYSTEM OPERATION

3.1 600-2703 CHASSIS

The PCIe-412 is installed into is a 20 slot rack mountable chassis. The chassis provides access to five x8 PCI Express slots, eight x4 PCI Express slots and two PCI-X slots. All slots can accommodate standard height and full length PCI Express and PCI-X add-in cards. The chassis also contains three drive bays that may be used by the user to install anything for their particular application. There are several ATX four pin peripheral power connectors available from the power supply.

The chassis contains a 500W power supply. Tables 3-1 through 3-5 show the power consumption for the Cyclone Microsystems boards and the power supplied to the PCI Express and PCI-X slots. However, the power supply is not designed to supply maximum power to each slot and it is up to the user to determine if total load of their add-in cards is acceptable. Note that the PCIe-408 is installed in and powered by the host supply. After subtracting the PCIe-403 and PCIe-412 board, there is 451.2W of power remaining for all add-in cards. Table 3-6 shows the amount of current per supply rail that is available. Again, note that the maximum currents listed exceed the power available. Taking into consideration the maximum power that can be supplied to a particular slot, the current available per supply rail and the total power available to the system, one can determine the number of add-in cards that can be installed into the 600-2703. Additionally, if the user installs any peripheral devices into the available drive bays and utilizes power from the peripheral power connectors, this power would also have to be subtracted from the total power available.

As an example, if a user had identical PCI Express cards that draw 2.0A of +3.3V and 1.4A of +12V, that would be a total of 23.4W. The power draw for the card is below 25W, the PCI Express Specification for the maximum power for a add-in card, so this board may be used in the PCIe-412. In this case, all thirteen available PCI Express slots can be filled, since the +3.3V draw would be 26A and the +12V draw would be 18.2A and the total power draw would be 304W. However, if one would like to add a PCI-X board to this configuration, there would be 147W available, but only 1.8A of +3.3V available.

3.2 POWER CONSIDERATIONS

Table 3-1. PCIe- 412 Power Requirements

Voltage	Current Typical	Current Maximum
+3.3V	1.2 Amps	1.4 Amps
+5V	5.4 Amps	6.9 Amps
+12V	0.02 Amps	0.04 Amps

Table 3-2. PCIe- 403 Power Requirements

Voltage	Current Typical	Current Maximum
+3.3V	0.61 Amps	0.72 Amps
+12V	0.43 Amps	0.57 Amps

Table 3-3. PCIe- 408 Power Requirements

Voltage	Current Typical	Current Maximum
+3.3V	0.32 Amps	0.37 Amps
+12V	0.25 Amps	0.35 Amps

Table 3-4. Power Supplied Per PCIe Slot

Voltage	Current Maximum	Voltage Tolerance
+3.3V	3.0 Amps	+/- 9%
+12V	2.1 Amps	+/- 8%

* Required by the PCI Express Card Electromechanical Specification Revision 1.0a. Note that the total power for each PCIe shall not exceed 25W.

Table 3-5. Power Supplied Per PCI Slot

Voltage	Current Maximum	Voltage Tolerance
+3.3V	7.6 Amps	+/- 0.3V
+5V	5.0 Amps	+/- 5%
+12V	0.5 Amps	+/- 5%
-12V	0.1 Amps	+/- 10%

Table 3-6. Power Available for All Add-in Cards

Voltage	Current Maximum
+3.3V	27.8 Amps
+5V	10.0 Amps
+12V	31.4 Amps
-12V	1.0 Amps

Airflow in the 600-2703 chassis is provided by four 50 CFM fans located across the rear of the board installation area.

CHAPTER 4
SYSTEM POWER UP

4.1 SYSTEM POWER UP

The host PC with the PCIe-408 installed controls power-up for the entire system. The PCI Express cable should be connected between the PCIe-408 and the PCIe-403, which is installed into the PCIe-412, and the 600-2703 power cord should be connected to the chassis and plugged in to a power socket. There is a power button on the front of the 600-2703 Expansion Chassis but if is not connected and serves no practical purpose in this application. When the host PC is powered on, a signal is sent over the PCI Express cable to turn on the 600-2703. If the chassis does not power up, make sure that all cards are seated properly, the chassis is plugged in and the PCI Express cable is connected properly. There are only two LEDs on the front of the expansion chassis that have meaning. The PWR LED indicates that the chassis is powered. The FANC2 LED indicates that the fans are running.

4.2 SEATING OF CARDS

Unlike standard PC applications, the 2703 Expansion Systems has a narrow lower gate that precisely engages the lower end of the PCI Express Add-In board's face panel. The purpose is to insure correct electrical connectoring mating of up-plugged boards. Failure to accurately mate the lower end of the face panel with the chassis lower gate will lead to the board not being recognized by the host.

4.3 LINK INDICATION - LED DEFINITION PCIE-408

There are many LED indicators on all three of the printed circuit boards (PCBs) that tell the user the status of all links and individual lanes. Also, see Figure 5-4. The PCIe-408 has two banks of eight LEDs. These LEDs are located on the top side or component side of the PCB. Each LED corresponds to one lane of that particular link. One bank is labeled "UP LN 0" (upstream) and the other bank is labeled "DWN LN 0" (downstream).

The eight upstream LEDs give the state of the link from the PC host that the PCIe-408 is installed into to the PCIe-408. If the PCIe-408 is installed into a x8 of x16 slot, then all eight of the upstream LEDs should be on. Since the PCIe-408 upstream port is an x8 link, only eight lanes of a x16 slot will be used. If less than the eight LEDs are on, there is a problem with the link between the PC host and the PCIe408. If the PCIe-408 is installed into a x4 PCIe slot (down-shifting), then only the first four LEDs will be on and the link is trained at x4. If none of the upstream LEDs are on, turn off the host PC and make sure that the PCIe-408 is properly seated into the PCIe connector.

The eight downstream LEDs indicate the status of the link connecting the PCIe-408 to the PCIe-403 via the PCI Express cable. If the PCIe-408 is installed into an x8 or a x16 slot and the eight upstream LEDs are on, the PCIe-408 is connected via the PCIe cable to the PCIe-403, all eight of the downstream LEDs should be on. If the PCIe-408 is installed into a x4 slot, there still should be all eight downstream LEDs on. If less than eight LEDs are on, check to make sure that the cable is properly connected to each board. Also, make sure that the PCIe-403 is properly seated into the PCIe-412.

4.4 LINK INDICATION - LED DEFINITION PCIE-403

The PCIe-403 has four groups of LEDs. The group of eight LEDs labeled “CABLE” is the upstream link to the PCIe-408 see Figure 5-3. The groups of eight LEDs labeled “A0” and “A2” are downstream links to PCI Express switches that drive slots 7 through 13 and slots 0 through 6, respectively. The group of four LEDs labeled “B0” is the downstream link to the PCI Express to PCI-X bridge. Note that all of the above LEDs should be on at all times. If any of the LEDs are not lit, there is a hardware problem between the PCIe-403 and the PCIe-412.

4.5 LINK INDICATION - LED DEFINITION PCIE-412

The PCIe-412 has several sets of surface mount located on the top side of the PCB see Figure 5-2. The LEDs are arranged in groups of either eight of four LEDs. As with the above boards, each LED corresponds to an individual lane within that particular link. The are twenty one groups of LEDs and their definition is shown in Table 4-1. Additionally, there are fourteen individual LEDs. These LEDs are labeled PWR0 through PWR13. These LEDs are illuminated and simply indicate when an add-in card is installed and powered in the corresponding slot. All of the LEDs labeled “UP” or “DOWN”, the LEDs between the PCIe-403 and the PCIe-412 and between the PCI Express switches, should be on at all times. If they are not on make sure that the PCIe-403 is seated properly into the PCIe-412. The slot LEDs indicate the active lanes to the corresponding add-in card. If no add-in card is installed into a particular slot, the LEDs for that slot will be off. If a x1 or x4 add-in card is installed into a x8 slot, only 1 (position 0) or 4 LEDs (LEDs 0 through 3) respectively, will be on. Similarly, x1 add-in cards installed into x4 slots should only have the first LED on. Add-in cards that are down-shifted, x8 cards in x4 slots, should have all four of the lane indicator LEDs on.

Table 4-1. PCIe-412 LED Banks

LED LABEL	LED FUNCTION
SLOT0 0->3	Slot 0 is a four lane port
SLOT1 0->3	Slot 1 is a four lane port
SLOT2 0->3	Slot 2 is a four lane port
SLOT3 0->3	Slot 3 is a four lane port
SLOT4 0->7	Slot 4 is an eight lane port
SLOT5 0->7	Slot 5 is an eight lane port
SLOT6 0->7	Slot 6 is an eight lane port
SLOT7 0->7	Slot 7 is an eight lane port
SLOT8 0->7	Slot 8 is an eight lane port
SLOT9 0->3	Slot 9 is a four lane port
SLOT10 0->3	Slot 10 is a four lane port
SLOT11 0->3	Slot 11 is a four lane port
SLOT12 0->3	Slot 12 is a four lane port
SLOT13 0->7	Slot 13 is an eight lane port
UP A0 0->7	x8 link from the PCIe-403 to the PCIe-412 (U12)
UP 0 0->	x8 link between PCIe switches, U17 to U16
DOWN 0 0->7	x8 link between PCIe switches, U16 to U17
UP A2 0->7	x8 link between PCIe-403 to the PCIe-412 (U16)
UP B0 0->3	x4 link between the PCIe-403 and PCIe-to-PCI-X bridge
UP 1 0->7	x8 link between PCIe switches, U11 to U12
DOWN 1 0->7	x8 link between PCIe switches, U12 to U11

CHAPTER 5
PHYSICAL CONFIGURATION

5.1 PHYSICAL CONFIGURATION

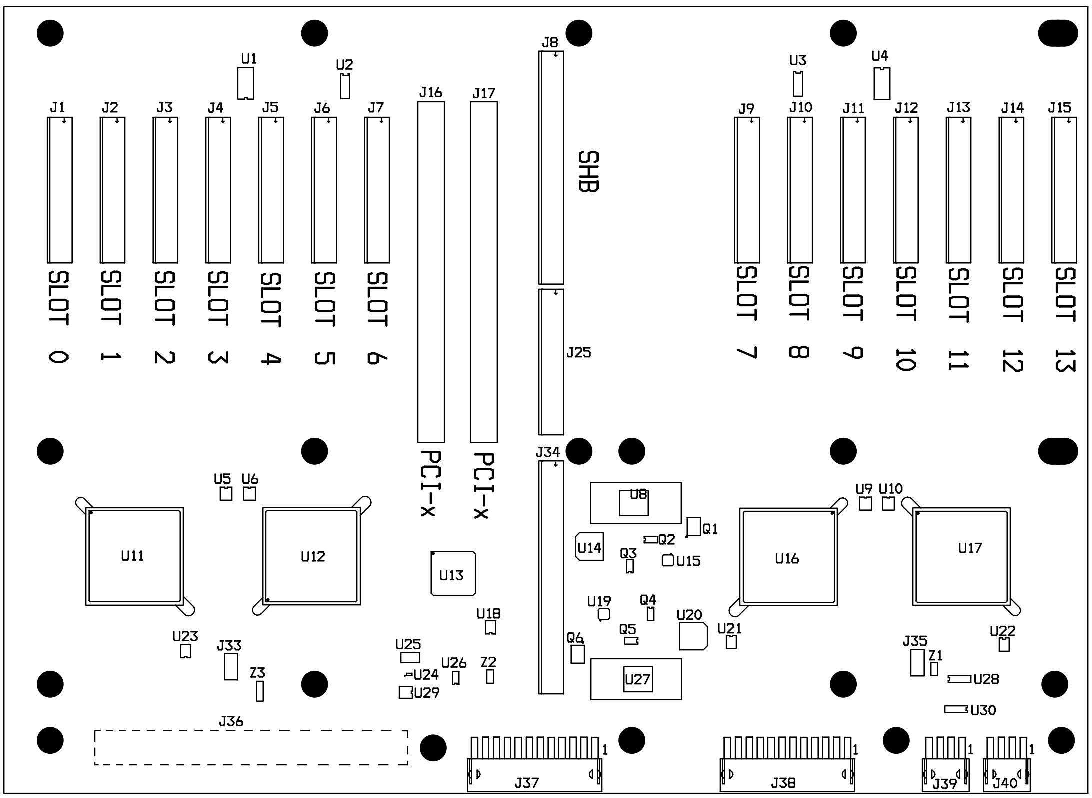


Figure 5-1. PCIe-412 Physical Configuration

Figure 5-1 is a physical diagram (not to scale) of the PCIe-412 adapter, showing the location designators of jumpers, connectors, and major ICs. Refer to this figure when component locations are referenced in the manual text.

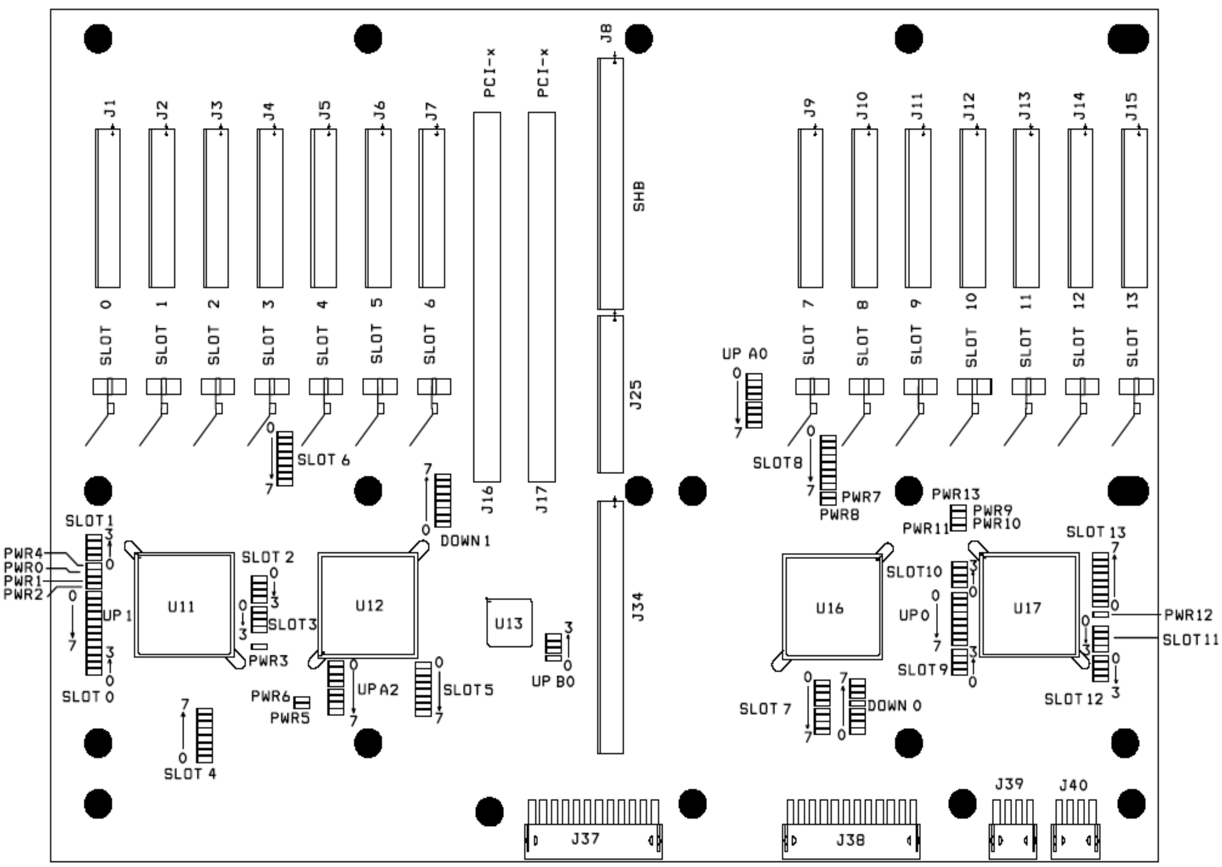


Figure 5-2. PCIe-412 LED Definition

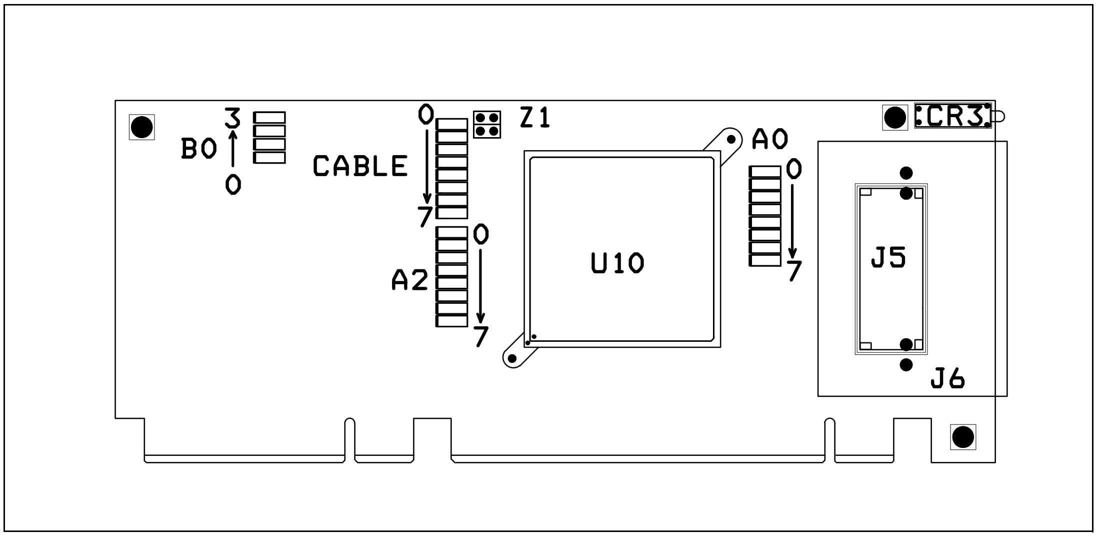


Figure 5-3. PCIe-403 LED Definition

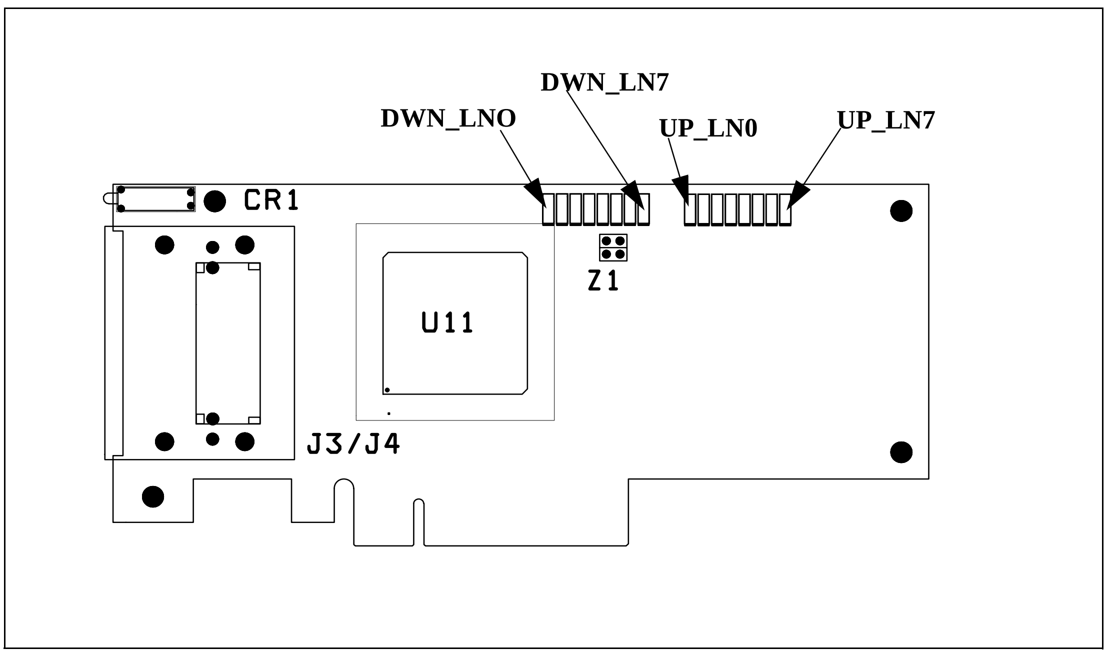


Figure 5-4. PCIe-408 LED Definition

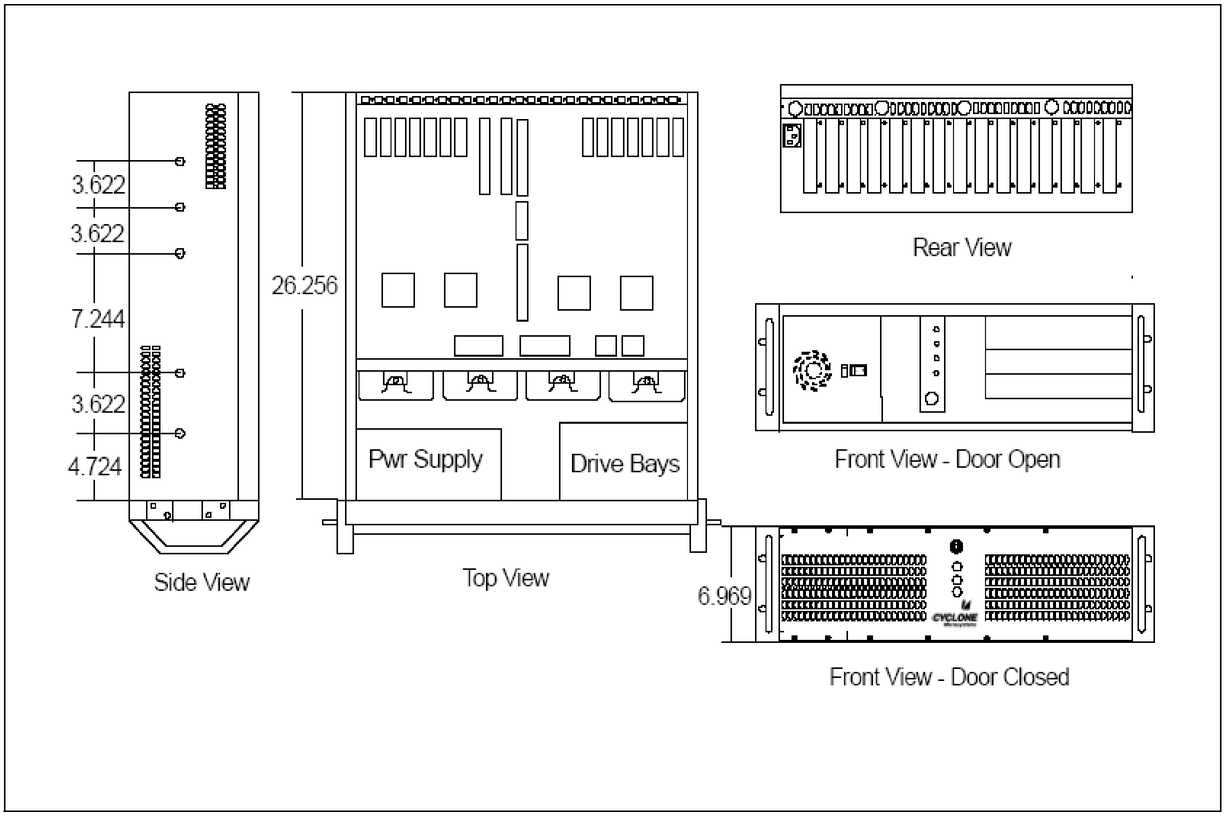


Figure 5-5. 600-2703 Chassis Drawing



Figure 5-6. 600-2703 Chassis

CHAPTER 6
REFERENCE

6.1 REFERENCE MANUALS

PEX 8532 Versatile PCI Express Switch Data Book Version 1.1
PEX 8114 ExpressLane PCI Express-to-PCI/PCI-X Bridge Data Book Version 1.0
PLX Technology, Inc.
Sunnyvale, CA
(800) 759-3735
www.plxtech.com

PCI Express Base Specification Revision 1.0a
PCI Express Card Electromechanical Specification Revision 1.0a
PCI Express External Cabling Specification Revision 0.7
PCI Local Bus Specification Revision 2.2
PCI-X Addendum Revision 1.0
PCI Special Interest Group (PCISIG)
5440 SW Westgate Dr., #217 Portland OR 97221
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(503) 297-1090 (Fax)
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